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Brief 66-10165

NASA TECH BRIEF

Gallium Alloy Films Investigated for Use as Boundary Lubricants

The problem:

Petroleum-base lubricants are unsatisfactory in high-temperature or vacuum environments due to their prohibitive evaporation rates. The metal gallium is known to have excellent lubricant properties of fluidity and low vapor pressure for these environments. However, gallium is extremely corrosive to most common bearing materials, and forms alloys with these materials.

The solution:

Alloy gallium with other low melting-point metals to reduce corrosivity and formation of undesirable alloys.

How it's done:

Metals such as indium and tin exhibit vapor pressures quite close to that of gallium through a fairly wide temperature range, and may be alloyed with gallium to produce low-friction coatings. Thin coatings, on the order of 0.001 inch, of various alloys of these three metals exhibit low-friction and wear-reduction properties in varying degree, depending upon the composition of the particular alloy. Gallium–tin alloys are approximately as effective as gallium alone in wear resistance and a gallium–indium–tin alloy (20–60–20) is 10 to 20 times as effective in reducing wear. Compared to uncoated stainless-steel surfaces, the gallium–indium–tin alloy reduces friction to as little as one-eighth and reduces wear to one-ten-thousandth.

Notes:

1. Friction and wear tests were conducted with a hemispherically tipped rider sliding on a flat disk specimen under a load of 1,000 grams. Both disk and rider were of 440-C stainless steel. Experiments were conducted in ambient temperature to a vacuum of 10^{-11} mm Hg.
2. Additional tests in a vacuum environment indicate that high indium-content coatings effectively reduced friction and wear of nickel disks with nickel riders.
3. Results of this investigation indicate that the addition of other soft metals to gallium films appreciably reduced corrosive wear normally encountered with gallium.
4. Further information concerning this invention is presented in NASA TN-D-2721, "Friction and Wear of Low-Melting Binary and Ternary Gallium Alloy Films in Argon and in Vacuum" by Thomas J. Kuczkowski and Donald H. Buckley, March 1965, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151; price $1.00
5. A related innovation is described in NASA Tech Brief B63-10337, May 1964. Inquiries may also be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio, 44135
   Reference: B66-10165

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546.

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Category 03